HAMPTON ROADS THIRD HARBOR CROSSING

Technical Memorandum No. 2:

DESIGN BASIS MEMORANDUM

Prepared by

HDR Engineering, Inc.
Alexandria, Virginia

For

Department of Rail and Public Transportation
and
Virginia Department of Transportation
Richmond, Virginia

March 2003
(Revised July 2003)

HAMPTON ROADS 3rd HARBOR CROSSING RAIL DESIGN CRITERIA

Track Geometry	Hampton Roads Transit Light Rail Transit	Hampton Roads Transit Diesel Multiple Units - DMU	Amtrak Inter-City Passenger Rail	Amtrak High Speed Passenger Rail	COMBINED SYSTEM CONTROLLING CRITERIA Light Rail Transit & Inter-City Passenger Rail	COMBINED SYSTEM CONTROLLING CRITERIA Diesel Multiple Units - DMU & Inter-City Passenger Rail
Maximum horizontal curvature/minimum curve radius see Note 1	D=19° 05' / 300 feet (@ grade ballasted) (c) D=57° 17' / 100 feet (in street desired) (c) Radius 82 feet (in street absolute) (c)	D= 22° 55' / 250 feet (a) (f)	D=10° / 570 feet (d)	D=11° 30' / 500 feet (b) D=10° / 570 feet (d)	D=10° / 570 feet (absolute limit) (d) D= 3°-30' / 1640 feet (desired limit) (d)	D=10° / 570 feet (absolute limit) (d) D=3°-30' / 1640 feet (desired limit) (d)
Required tangent lengths between reverse curves see Note 15	200 feet (desired) (c) greater of 100 ft or (c) 3 x design speed "mph" (minimum) 40 ft (absolute minimum w/ HRT approval) (c)	Greater of 100 feet or (g) Lmin =3 x velocity "mph" (d) for passenger rail	Greater of 100 feet or (g) Lmin =3 x velocity "mph" for passenger rail	Greater of 100 feet or (g) Lmin =3 x velocity "mph" (d) for passenger rail	Minimum: Greater of 100 feet or (g) Lmin =3 x velocity "mph" (d) Desired: Greater of 200 feet or (c) Lmin =3 x velocity "mph" (d)	Minimum: Greater of 100 feet or (g) Lmin =3 x velocity "mph" (d) Desired: Greater of 200 feet or (c) Lmin =3 x velocity "mph" (d)
Superelevation requirements	Eq (in) = Ea +Eu = 3.96(V^2)/R (c) Ea = 2.64(V^2)/R - 0.67 (c) Desirable max. - Ea max = 4" Eu max = 3" (c) V - "mph" R - "ft"	Ea = 0.0007(V^2)D (d) Ea max=6" (d) (h) Eu of 2.5 - 4.75 inches (d) (note 2)	Ea = 0.0007(V^2)D (d) Eu of 2.5 - 4.75 inches (d) (note 2) Eu max = 3 inches (h)	Ea = 0.0007(V^2)D (d) Eu of 2.5 - 4.75 inches (d) (note 2) Up to 9 inches Eu for tilt equipment (b)	Ea = 0.0007(V^2)D (d) Ea max=4 inches (c) Max. Eu of 2.5 - 3 inches (d) (g) (h)	Ea = 0.0007(V^2)D (d) Ea max=6 inches (d) (g) Max. Eu of 2.5 - 3 inches (d) (g) (h)
Spiral length requirements	Greater of: Ls = 1.10EaV Ls = 0.82EuV Ls = 31Ea 60 ft (c)	Lmin = 1.63EuV (d) Lmin = 1.22EuV when above is costly (d) Greater of LS=62Ea (V<50) (g) Ls=83Ea (50<V<70) Ls=124Ea (70<V<125) and, when D<1°30'	Lmin = 1.63EuV (d) Lmin = 1.22EuV when above is costly (d) Greater of LS=62Ea (V<50) (g) Ls=83Ea (50<V<70) Ls=124Ea (70<V<125) and, when D<1°30'	Lmin = 1.63EuV #1 Lmin = 62 Ea for tilt equipment #2 Lmin = 1.22EuV when #1 is costly #3 use the greater of #1 & #2 or #2 & #3 (d) Greater of LS=62Ea (V<50) (g) Ls=83Ea (50<V<70) Ls=124Ea (70<V<125) and, when D<1°30'	Lmin = 1.63EuV (desired) (d) Lmin = 1.22EuV (minimum) (d) Greater of LS=62Ea (V<50) (g) Ls=83Ea (50<V<70) Ls=124Ea (70<V<125) and, when D<1°30'	Lmin = 1.63EuV (desired) (d) Lmin = 1.22EuV (minimum) (d) Greater of LS=62Ea (V<50) (g) Ls=83Ea (50<V<70) Ls=124Ea (70<V<125) and, when D<1°30'
Maximum grade - inside tunnels	4% (c) 7% max for short sustained grade (c) 4% (f)	4% (f)	4% acceptable (h) (2 - 2.5% for less operational cost) (h) <=2.5% (g)	3 - 3.25% from rest @ 75% traction (b) 4% @ speed	Maximum: 4% (c) (h) Desired: <=2.5% (g) (h)	Maximum: 4% (c) (h) Desired: <=2.5% (g) (h)
Maximum grade - outside tunnels	4% (c) 7% max for short sustained grade (c) 4% (f)	4% (f)	4% acceptable (i) (2 - 2.5% for less operational cost) (i) <=2.5% (h)	3 - 3.25% from rest @ 75% traction (b) 4% @ speed	Maximum: 4% (c) (h) Desired: <=2.5% (g) (h)	Maximum: 4% (c) (h) Desired: <=2.5% (g) (h)
Length of vertical curve/ minimum radius, for crests	Lmin = 200A desirable (c) Lmin = 100A preferred (c) Lmin = (A x V^2)/45 minimum (c) Rmin = 820 ft A=|G2-G1| (f) G1, G2 = grade in percent	2000 ft. minimum radius (a) (g)	Lmin = (DV^2K)/a (note 3) (d) D=|G2-G1| K=2.15 "ft" a=0.60 ft/sec-sec (passenger) Lmin=|G2-G1|/0.0095 (i) G1, G2 = grade in percent	2000 ft minimum vertical curve length (b) Lmin = (DV^2K)/a (note 3) (d) D=|G2-G1| K=2.15 "ft" a=0.60 ft/sec-sec (passenger) Lmin=|G2-G1|/0.0095 (i)	Lmin=|G2-G1|/0.0095 (i) G1, G2 = grade in percent	Lmin=|G2-G1|/0.0095 (i) G1, G2 = grade in percent
Length of vertical curve/ minimum radius, for sags	Lmin = 200A desirable (c) Lmin = 100A preferred minimum (c) Lmin = (A x V^2)/45 absolute minimum (c) Rmin = 820 ft A=|G2-G1| (f) G1, G2 = grade in percent	2000 ft. minimum radius (a) (g)	Lmin = (DV^2K)/a (note 3) (d) D=|G2-G1| K=2.15 "ft" a=0.60 ft/sec-sec (passenger) Lmin=|G2-G1|/0.0095 (i) G1, G2 = grade in percent	2000 ft minimum vertical curve length (b) Lmin = (DV^2K)/a (note 3) (d) D=|G2-G1| K=2.15 "ft" a=0.60 ft/sec-sec (passenger) Lmin=|G2-G1|/0.0095 (i)	Lmin=|G2-G1|/0.0095 (i) G1, G2 = grade in percent	Lmin=|G2-G1|/0.0095 (i) G1, G2 = grade in percent
Required length of constant grade between vertical curves	Greater of: 100 feet or 3 x V (c)	Greater than 100 ft (general) Lmin = 3 x V for pass. rail transit (d)	Greater than 100 ft (general) Lmin = 3 x V for pass. rail transit (d)	Greater than 100 ft (general) Lmin = 3 x V for pass. rail transit (d)	Greater of: 100 feet or 3 x V (c)	Greater of: 100 feet or 3 x V (c)

Data sources
a: Colorado Railcar Manufacturing, LLC
b: Bombardier Transportation - indicates Acela Express equipment capabilities
c: Hampton Roads Transit Functional Design Criteria - June, 2002
d: AREMA
e: Norfolk-Southern reply to AASHTO/NSBA Steel Bridge Collaboration
f: Hampton Roads Transit Tunnel Design Criteria Correspondence - June 25,2002
g: Amtrak MW1000
h: Amtrak letter of 3/27/02 and meeting of 9/20/02
i: Amtrak direction per meeting of 12/03/02

Note 1: Degree of curve, D, expressed as arc definition.
Note 2: FRA approval required for underbalanced elevation greater than 4 inches.
Note 3: Consider as absolute minimum, longer curve is desirable if possible.
Note 15: TTDC - Tidewater Transportation District Commission

HDR

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Introduction

The Virginia Department of Rail and Public Transportation (DRPT) requested that HDR provide rail information that will be required in support of the preliminary engineering activities for the Hampton Roads Third Harbor Crossing (HR3X). DRPT has identified the major stakeholders in the multimodal rail portion of this project as the Virginia Department of Transportation (VDOT), DRPT, Amtrak, the Federal Railroad Administration (FRA), and Hampton Roads Transit (HRT).

As part of the requested assistance, HDR has identified alternative operating scenarios, as defined by the relevant stakeholders, and provided preliminary rail design criteria regarding rail elements of the HR3X. The operating scenario and preliminary select design criteria, presented to DRPT and VDOT in Technical Memorandum No. 1 (November 2002), have been reviewed and agreed to in principle by all of the major project stakeholders. The resulting recommendations and design basis criteria are presented in this report (Technical Memorandum No. 2) and are being submitted to DRPT and VDOT for incorporation into the preliminary engineering design of the HR3X, as of current rail and transit design standards, January 2003.

It is anticipated that concurrence by all stakeholders will ultimately be reached on a common operations strategy that would then be utilized in the selection of final design criteria to accommodate operations of a future rail component of the HR3X. Input of all stakeholders has been incorporated into the revised alternative operating plans that address the needs of DRPT, HRT, and Amtrak.

The information presented below is the outcome of meetings held between HDR, VDOT, HRT and its consultants, and Amtrak. Additional information was collected from other sources and also incorporated into this document.

1. Project Description

A. General Project Area Description

The Virginia Department of Transportation (VDOT), in cooperation with the Federal Highway Administration (FHWA), is proposing to construct a new bridge-tunnel crossing of Hampton Roads in southeastern Virginia. "Hampton Roads" is the name of the water body and harbor located between the mouth of the James River (to the west) and the Chesapeake Bay (to the east). However, the term "Hampton Roads" has been adopted locally to also refer to the metropolitan region that surrounds the Hampton Roads Harbor in southeastern Virginia. The Hampton Roads area includes the cities of Chesapeake, Hampton, Poquoson, Newport News, Norfolk, Portsmouth, Suffolk, and Virginia Beach, as well as the counties of Isle of Wight and York. In conjunction with the highway crossing of the harbor, a multi-modal incorporation of rail and transit within the crossing is to be evaluated. This report examines the probable operating scenarios of Hampton Roads Transit (HRT) and Amtrak trains through the Hampton Roads Third Harbor Crossing as the likely rail and transit modes. In addition, a compilation of design parameters compatible with the likely rail and transit modes has been developed.

B. Alignment Geometry

The preferred alignment alternative selected by VDOT and FHWA for the Hampton Roads Crossing study is identified as Candidate Build Alternate 9 (CBA 9). (See Figure 1) Descriptions of rail and transit provisions for the crossing are based on an evaluation of this preferred alignment alternative. CBA 9, referenced in the Conceptual Engineering Study Technical Report, dated October 1999, represents the most recent version of the alignment and is the geometric alignment referenced in this report.

The proposed alignment would provide a new crossing of Hampton Roads Harbor, parallel to the current I-664 and Monitor-Merrimac Memorial Bridge-Tunnel with connections to I-664 in the City of Chesapeake, I-664 in the City of Newport News, and I-564 in the City of Norfolk. More specifically, the selected alternative begins on the Peninsula at the I-664/I-64 interchange in the City of Hampton and would widen I-664 to the I-64/I-264 interchange in the City of Chesapeake. The alignment includes an interchange with I-664/I-564 near the south approach structure of the Monitor-Merrimac Memorial Bridge-Tunnel connecting to a new roadway and bridge tunnel extending east from I-664 to I-564 in the City of Norfolk. This interchange would provide access to both the existing Monitor-Merrimac Memorial Bridge-Tunnel as well as the new parallel bridge tunnel. A second interchange on the new facility will connect with a 4-lane component of the selected alternative running south along the eastern side of Craney Island and terminating at VA 164 (Western Expressway) in the City of Portsmouth.

C. Definition of Railroad/Transit Operations

The study of transit and rail provisions of the Third Harbor Crossing encompass an analysis of the probable operating scenarios of a fleet of rail vehicles under the authority of HRT and/or Amtrak. The bridges and tunnels to be constructed under CBA9 are not to be used for freight railroad traffic at this point in time, or anytime in the future.

HRT currently operates bus service in the Hampton Roads area and is in the planning stages of developing rail transit for the Norfolk area and the Hampton Peninsula. (See Figure 2.) Two independent rail transit systems are being studied.

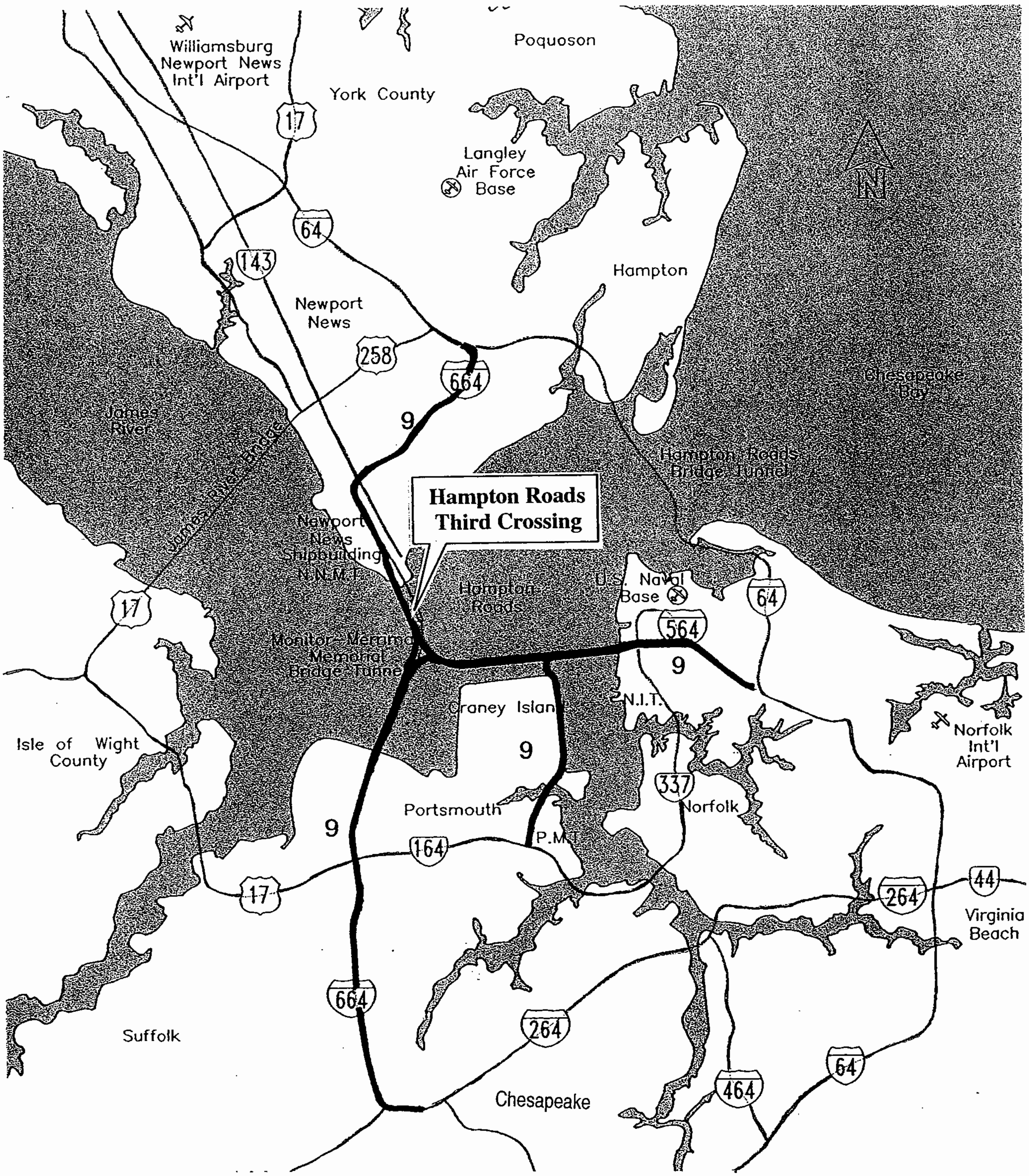


Figure 1
Candidate Build Alternative 9

Source: Hampton Roads Crossing Study: Federal Highway Administration and Virginia Department of Transportation

The Norfolk area system is expected to utilize electrified Light Rail Transit (LRT) vehicles, powered by an overhead catenary, which will operate on dedicated tracks. The planned LRT routes are in the early stages of development. The planned Norfolk/Southside Harbor transit lines include:

- Naval Station Loop - LRT loop track within the U.S. Naval Base north of the intended I-564 alignment.
- Downtown Norfolk Connection - LRT alignment that would extend LRT service from the Naval Station Loop further east adjacent the present alignment of the Norfolk Southern (NS) Railway and link to a separate planned east-west LRT line north of the Elizabeth River.
- East-West Line – LRT alignment north of the Elizabeth River providing service parallel the river and I-264.

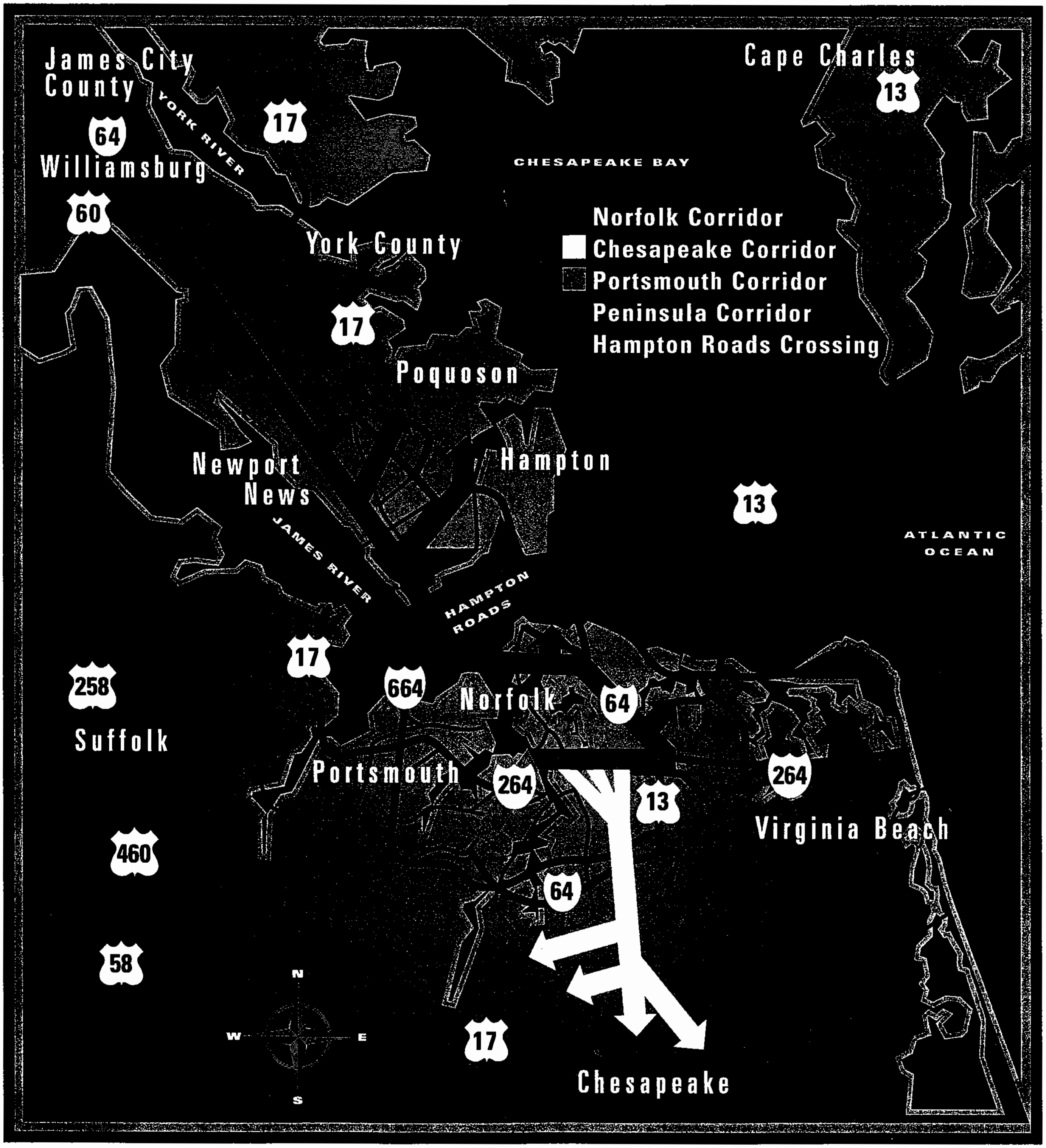
A separate transit system and vehicle type are being planned to service the Hampton Peninsula. HRT's intended transit plan for the Peninsula utilizes Diesel Multiple Units (DMUs) traveling along a north-south alignment, west of the existing CSX railway line and I-664. The Peninsula transit line will service Newport News Shipbuilding, the North End historic district, a relocated Amtrak station, City Hall and a new Transportation Center. HRT's master planning to date has not included a detailed study of a harbor crossing. However, [redacted]o. HRT has [redacted].

Under the projected DMU service, trains from the Peninsula would cross the harbor along the I-664 alignment, then follow the I-564 alignment toward Norfolk and terminate at a terminal station on the Norfolk port shore adjacent to the south boundary of the Naval Base. The terminal station would include a security screening station to allow transfer from the DMU system to the Naval Base LRT Loop system. Under the DMU operating plan, the transit vehicles could share tracks with inter-city passenger trains (Amtrak).

Amtrak currently operates limited passenger rail service from the Northeast Corridor (NEC) via Richmond to Hampton Roads. Service is provided on the Peninsula along CSX tracks with a terminal station in Newport News. Shuttle bus service currently links the Hampton Roads Amtrak station in Newport News with Norfolk and Virginia Beach. Amtrak service through the HR3X would entail train movements along the northern leg of I-664 and a connection to the I-564 leg toward Norfolk. The harbor crossing would allow for a Norfolk extension of the Newport News Peninsula Amtrak service. Continued operation of single level passenger coaches powered with diesel locomotives is envisioned. Provisions for operation of future service of electrified locomotives can be accommodated with little impact.

Detailed discussions of operating scenarios are presented below.

HAMPTON ROADS REGIONAL TRANSIT POTENTIAL ALIGNMENTS



Hampton Roads Transit

Figure 2

2. Amtrak Operations

A. Potential Operations Scenarios

Amtrak currently operates two daily Acela Regional (formerly Northeast Direct) round trips from Boston and New York to Newport News via Washington, DC, and Richmond. A Friday-only southbound Acela Regional frequency from Boston to Newport News and a Friday-only Acela Regional train to Richmond also serve Newport News. The term "Acela" refers to the Northeast Corridor (NEC) service route operated by Amtrak. Three levels of Acela service are available: Express, Regional and Commuter. Different Acela trains travel at different speeds and are powered by different locomotive types.

Acela Regional service refers to the NEC service route traveled by the trains with more frequent station stops than the Acela Express. Amtrak utilizes primarily electric powered locomotives on the trip north of Washington and exclusively diesel-powered locomotives to the south. One of the round trips serving Newport News, the Twilight Shoreliner that was added in 1995, is an overnight train offering coach and sleeping accommodations as well as checked baggage service. All Amtrak frequencies to and from Hampton Roads provide coach and Business Class accommodations, as well as Amcafes or Amdinettes with sandwich, snack and beverage service. At Newport News, connection buses meet the trains to provide onward one-ticket Amtrak service to Norfolk and Virginia Beach.

The Norfolk – Virginia Beach – Newport News Metropolitan Statistical Area (MSA) in 2000 had just under 1.6 million residents, up 8.8% from 1.45 million residents in 1990, making it the most populous MSA in Virginia. Two-thirds of the Hampton Roads population lives south of the James River with one-third of the residents living north of the river in the Williamsburg – Newport News area. Consequently, current Amtrak service directly accesses only one-third of the metropolitan area population, with residents south of the river served only by connecting buses from Newport News.

There are no plans by Amtrak or the Commonwealth of Virginia to increase intercity rail service to Hampton Roads in the near future. However, over the next 10 – 12 years as the population in the area continues to grow and as Interstate highway travel times increase due to traffic exceeding highway and tunnel carrying capacity, Amtrak is projecting service to double to four daily round trips between Hampton Roads and the Northeast.

Being able to access the Norfolk – Virginia Beach populations directly by train could greatly increase the demand for intercity rail service and accelerate the need for additional passenger train frequencies to the Hampton Roads area. This is especially so if trip times between Richmond and Washington, DC, are substantially shortened as rail improvements are made and speed limits raised from 70 mph to 90 mph or 110 mph. Amtrak has modeled schedule patterns for such an eventuality with four – six – eight – ten trip frequencies as part of the Richmond to South Hampton Roads High Speed Rail Feasibility Study in early 2002.

B. Passenger Equipment

Almost all Amtrak Acela Regional trains that originate on the NEC and continue south of Washington, DC, use Amfleet I & II 84-seat and 60-seat coaches. Sandwich, snack, and beverage services are provided in Amfleet, Amcafe and Amdinette cars. Since these Acela Regional trains are extensions of Boston – Washington NEC frequencies, the equipment used is in most cases identical to the NEC passenger fleet. Additionally, the Twilight Shoreliner sleeping car service consists of Viewliner sleeping cars with two deluxe bedrooms, one handicapped accessible deluxe bedroom and 12 compartments, accommodating 30 passengers and one attendant.

As frequencies to Hampton Roads increase in future years, it is expected that passenger equipment used for Amtrak NEC services will, by and large, continue to equip Amtrak trains originating or terminating in Hampton Roads. Due to the clearance envelopes of the Hudson River and East River tunnels in New York City, future equipment will almost undoubtedly be single level intercity passenger cars, such as Talgo, Midwest Regional Rail (MWRRI) procurement vehicles, or similar car types that may be developed. It is doubtful that Acela Express electric trainsets will see service in the Hampton Roads area (even if electrification is later extended south of Washington to Richmond and Hampton Roads) since no future Acela trainset production is planned and all current trainsets are needed to protect Washington – New York – Boston schedules.

North of Washington, DC, electric locomotives power most Amtrak NEC services, whereas south of Washington, diesel locomotives operate all trains. This pattern of operation will continue for the foreseeable future with single unit GE Genesis P42 locomotives handling six to eight car Hampton Roads trains. However, as frequencies increase, EMD F59 PHI locomotives, similar to those handling regional Amtrak services in California, Washington State and North Carolina, could also power Hampton Roads trains. Should electrification eventually be extended beyond Washington to Richmond and Hampton Roads, Amtrak frequencies on this route would likely be handled by rebuilt AEM-7's, Bombardier HHL locomotives, or similar electric units.

C. Performance Simulations

Amtrak has run a series of Train Performance Calculator (TPC) simulations under varying conditions for the proposed HR3X assuming a 4% maximum grade within the tunnel and horizontal geometry consistent with the proposed HR3X alignment. Amtrak tested, through the use of simulation modeling, their equipment's ability to operate successfully and reliably through the tunnel using a single GE P42 Genesis locomotive and four, six and eight Amfleet cars. Assuming a top speed of 80 mph over this route segment, the modeling showed that the P42 locomotive was able to pull all three consist lengths through the tunnel, with the speed of an eight-car consist never dropping below 57 mph and a four-car consist never dropping below 66 mph.

When stops at the bottom of the tunnel and on the 4% grade were added, as well as reductions in rail adhesion to simulate wet rail conditions, the simulation test results varied significantly. Only the four-car consist was able to successfully run through the tunnel assuming 50% adhesion reduction from normal adhesion values, and its speeds dropped to 9 mph at one point. Both the six-car and eight-car consists stalled in the tunnel assuming 50% adhesion reduction from normal adhesion values. At 75% adhesion reduction from normal adhesion values, all three consists were able to negotiate the tunnel, but the eight-car consist did so with considerable difficulty. As a result, Amtrak has recommended that two fully operational diesel locomotives be the minimum power for operating anticipated six to eight car consists through the tunnel. Should the Hampton Roads route be electrified, no problems are anticipated with single unit operation of the much higher horsepower electric locomotives. The table below shows the horsepower per ton rating for the various train configurations used by Amtrak in their simulations.

AMTRAK OPERATIONS SCENARIO			
Train Consist *	**Horsepower****	**Weight**	**Horsepower Per Ton**
1 Locomotive + 4 Cars	4140 hp	362 tons	11.44
1 Locomotive + 6 Cars	4140 hp	476 tons	8.70
1 Locomotive + 8 Cars	4140 hp	590 tons	7.02
2 Locomotives + 4 Cars	8280 hp	496 tons	16.69
2 Locomotives + 6 Cars	8280 hp	610 tons	13.57
2 Locomotives + 8 Cars	8280 hp	724 tons	11.44

** P42 locomotive with Amfleet coaches*
*** Total HP values shown. Reduced HP values converted to tractive effort.*

Although flatter grades would result in lower inter-city train operating costs, especially if the second locomotive were not needed, they would result in substantially higher construction costs due to additional dredging to accommodate the longer tunnel transition sections and the overall additional tunnel lengths that would be required.

Amtrak has also evaluated additional design parameters and provided additional guidance. Based on the HR3X being designed to provide for passenger train service only, exclusive of freight, structures designed to accommodate Amtrak vehicles may be based on an AREMA design loading of Cooper E-60 in lieu of the heavier Cooper E-80 loading. Trackbed construction types were considered and a direct fixation trackbed is preferred in comparison with a ballasted deck.

- Dillingham Station
- 2nd Street West Station

HRT performed a conceptual level study of the Naval Base Extension of the proposed Norfolk east-west light rail system. However, this extension will need to be reexamined relative to heightened security requirements. Based on the earlier study, the primary issues were transit vehicle/Naval Base access and the proposed tunnel interface. Additional investigation will be required to assure that proper personnel access is provided. Profiles, grade separations, access routes and passenger circulation also need to be reviewed. Additionally, the issues of property reservation and coordination with the I-564 Inter-Modal Connector design are required.

The Norfolk East-West light rail transit line is intended to service an alignment north of the Elizabeth River. (See Figure 4.) Stations along the alignment include:

- Medical Center Station
- York Street Station
- Freemason District Station
- Plume Street Station
- Government Center Station
- Harbor Park Station
- NSU Station
- Ballentine Boulevard Station
- Ingleside Station
- Military Highway Station
- Kempsville Center Station

Both Norfolk/Southside Harbor lines would operate LRT vehicles powered by overhead electrical catenary. A single articulated low-floor vehicle with a seating capacity of 72 would most likely be utilized. The potential future use of a multiple vehicle consist will be considered as well. Peak headways are planned at 15 minutes.

2. Newport News Peninsula System Plan

Service over the Newport News Peninsula is planned as a Diesel Multiple Unit (DMU) service that would operate along existing CSXT freight tracks as well as along new, dedicated tracks. The north-south alignment would be located west of the CSX tracks and west of I-664. Stations planned at this time include:

- Amtrak Station
- Shipyard North Station
- 50th Street Station
- 41st Street Station
- 35th Street Transportation Center Station
- City Hall Station

3. Hampton Roads Transit Operations

A. HRT Master Plan Description

Hampton Roads Transit has been working with a number of consultants and local groups to develop preferred routes for rail transit within the region. The potential for rail transit has been studied since the early 1990's in the Hampton Roads area.

The region is made up of many local municipalities, and each locality is in a different phase of the study process. At this time, two separate transit systems are being planned for the region: (1) one system for the Peninsula and (2) the second system for the Norfolk/Southside Harbor area. HRT plans to use two different modes of transit technology, based on the suitability of their application. Service in the Norfolk/Southside Harbor area is to be provided by Electrified Light Rail Transit and the Peninsula service is to be provided by Diesel Multiple Units (DMU).

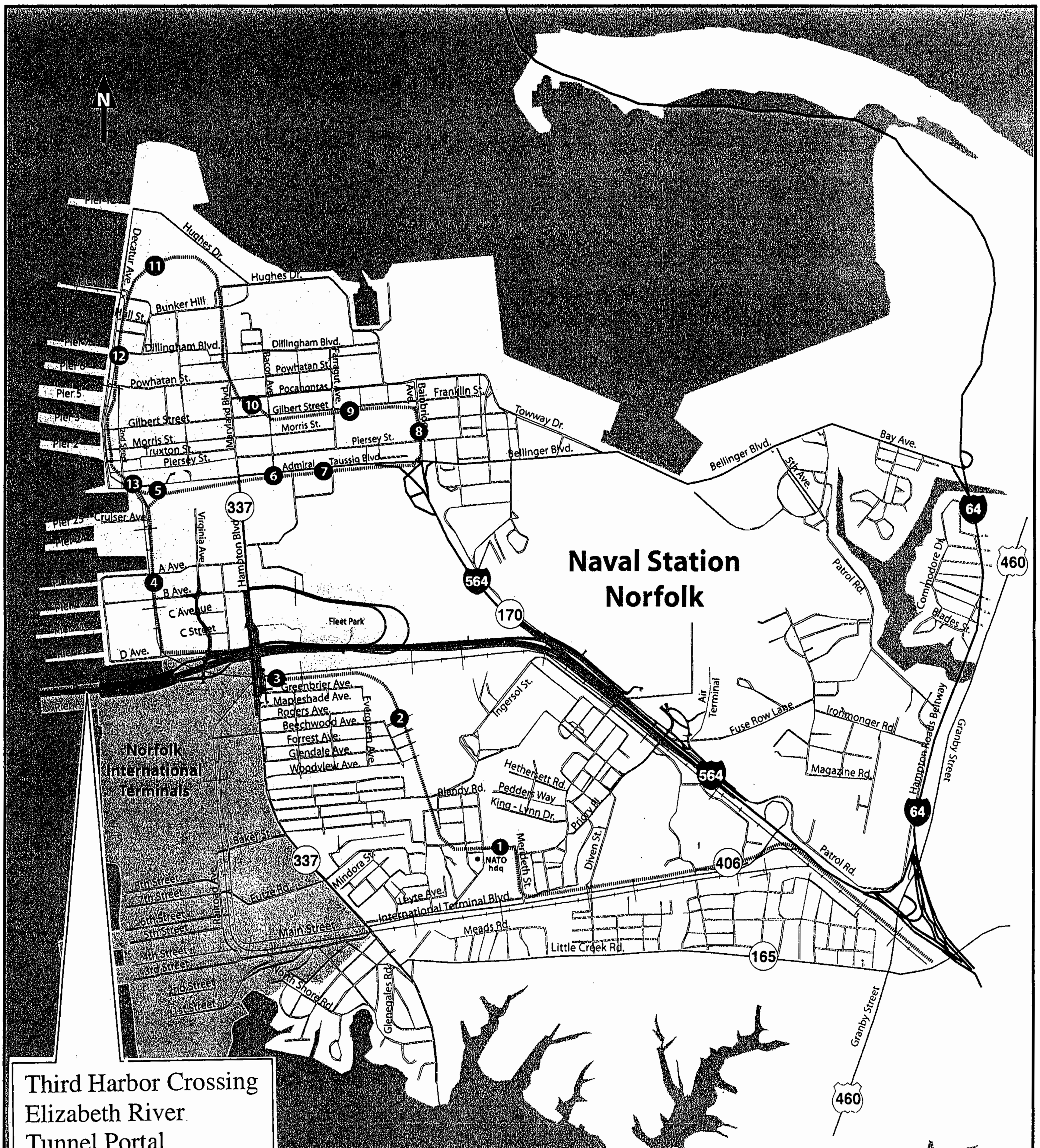
1. Norfolk/Southside Harbor Area System Plan

The study of rail transit in the Norfolk/Southside Harbor area has undergone some refinement in response to the results of a local referendum in Virginia Beach that resulted in a vote not to participate in the study. A Final Environmental Impact Statement (FEIS) document that included service to Virginia Beach is being altered to identify new "end-of-lines." Public input was sought to share information and evaluate alignment preferences. When the new alignment is determined, a supplement to the FEIS will be published. The Federal Transit Administration (FTA) has reviewed the documentation to date, and as of October 14, 2002 has authorized preliminary engineering to proceed.

Two lines are being planned for the Norfolk LRT system at this time. A loop line would provide service to the Naval Base with 13 stations planned along the route. (See Figure 3.) Passengers on the line would need to clear Naval security prior to entering the system. Current planned stations within the Naval Base include:

- NATO Station
- Beechwood Avenue Station
- Fleet Park Station
- B Avenue Station
- 2^{nd} Street East Station
- Medical Clinic Station
- Navy Exchange Station
- Bainbridge Station
- Farragut Station
- Pocahontas Station
- Pier 11 Station

Proposed Naval Station Norfolk LRT Alignment with I-564 Connector



LEGEND

1. NATO Station	4. B Avenue Station	7. Navy Exchange Station	10. Pocahontas Station	13. 2nd Street West Station
2. Beechwood Avenue Station	5. 2nd Street East Station	8. Bainbridge Station	11. Pier 11 Station	Proposed I-564 Connector
3. Fleet Park Station	6. Medical Clinic Station	9. Farragut Station	12. Dillingham Station	Proposed LRT Alignment & Stations

Figure 3

NORFOLK LIGHT RAIL TRANSIT

East – West Line

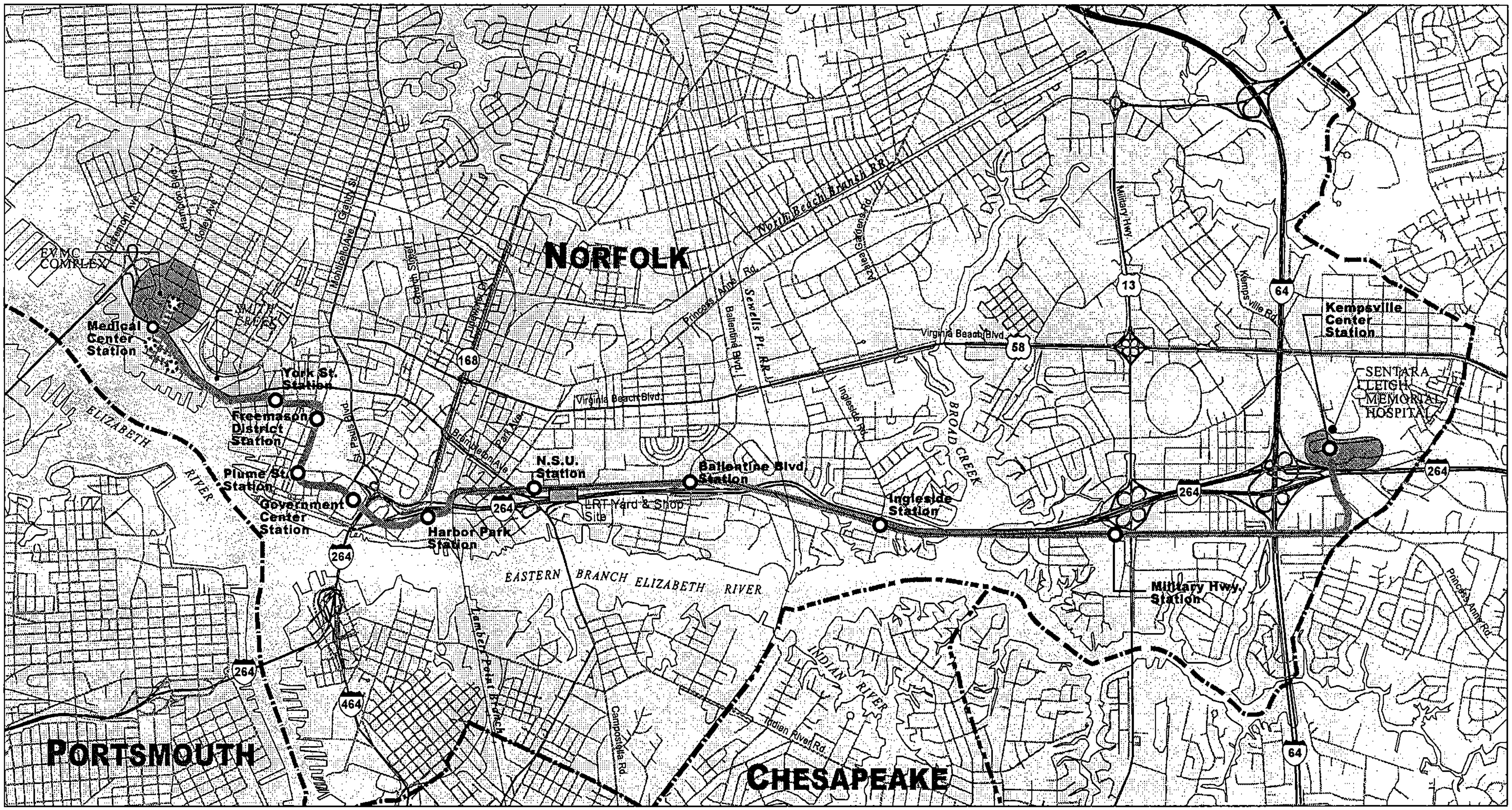
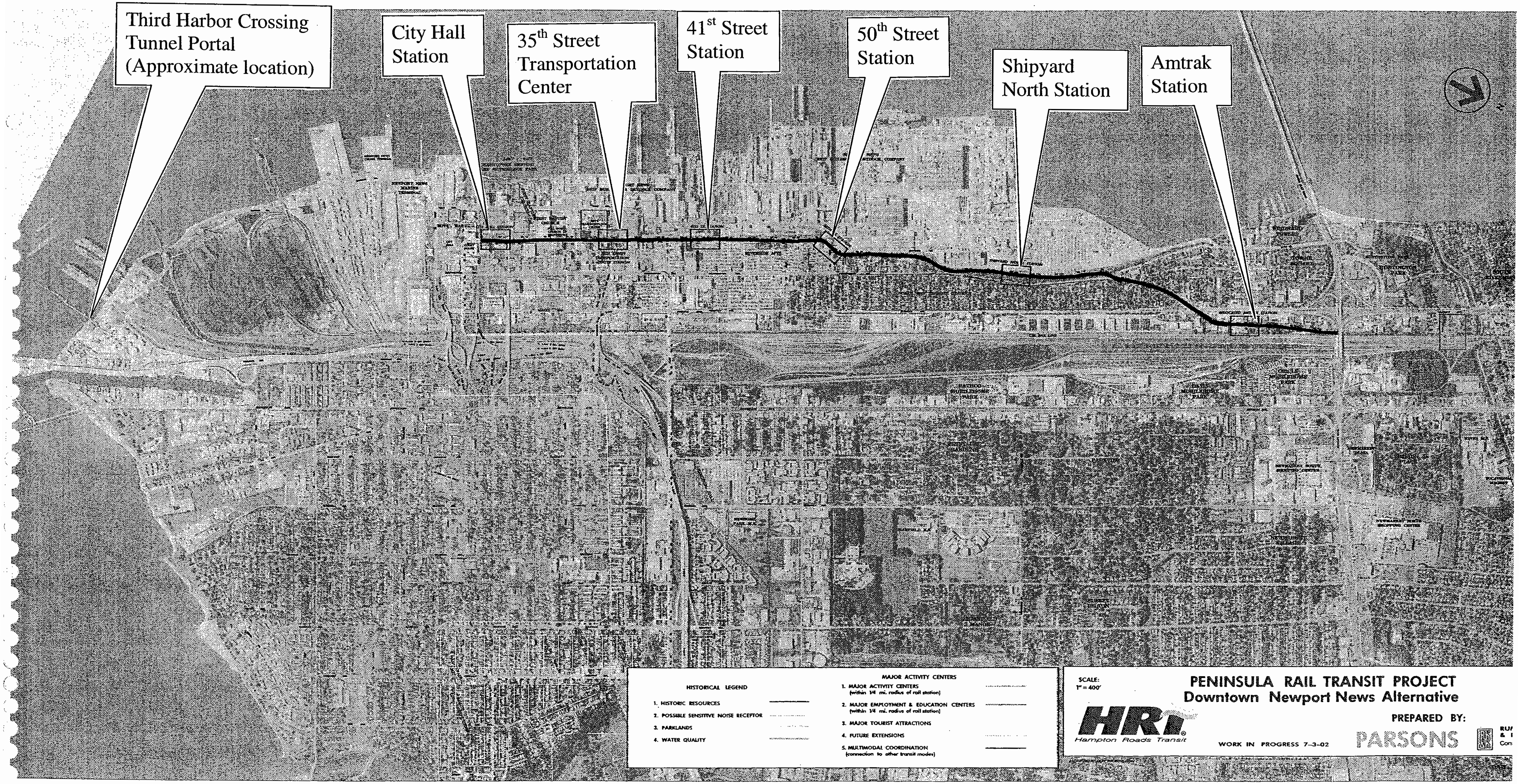


Figure 4



Third Harbor Crossing Tunnel Portal (Approximate location)
City Hall Station
35th Street Transportation Center
41st Street Station
50th Street Station
Shipyard North Station
Amtrak Station
HISTORICAL LEGEND
1. HISTORIC RESOURCES
2. POSSIBLE SENSITIVE NOISE RECEPTOR
3. PARKLANDS
4. WATER QUALITY
MAJOR ACTIVITY CENTERS
1. MAJOR ACTIVITY CENTERS (within 1/4 mi. radius of rail station)
2. MAJOR EMPLOYMENT & EDUCATION CENTERS (within 1/4 mi. radius of rail station)
3. MAJOR TOURIST ATTRACTIONS
4. FUTURE EXTENSIONS
5. MULTIMODAL COORDINATION (connection to other transit modes)
SCALE: 1" = 400'
PENINSULA RAIL TRANSIT PROJECT
Downtown Newport News Alternative
HRT
Hampton Roads Transit
PREPARED BY:
WORK IN PROGRESS 7-3-02
PARSONS

Figure 5

3. Third Harbor Crossing Transit Plan

HRT has yet to determine a detailed operating plan for the specific type of rail service through the HR3X. As the design of the tunnel progresses, a cooperative joint-service operating plan encompassing all modes of rail service will be refined. Based on HRT's current operating plans, Diesel Multiple Unit (DMU) operation is the preferred transit vehicle technology to use through the crossing. A DMU vehicle that complies with Federal Railroad Administration (FRA) safety regulations could operate within the corridor in mixed service with inter-city passenger trains (Amtrak and/or commuter service). DMU technology is evolving. A DMU developed by Colorado Railcar has received recent approvals from FRA, but to date, no FRA-compliant DMUs are currently in service. FRA-compliant vehicles are passenger equipment that meets design standards set by the FRA in areas such as strength and deformation resistance in the event of a crash.

DMU Service would originate on the Peninsula, traverse the HR3X, and terminate at a Transfer Station on the Southside Harbor shore adjacent I-564 and then turn back. From this transfer point, passengers could access bus service and the planned Norfolk LRT line.

LRT vehicles have not been eliminated from consideration for use within the HR3X. However, FRA regulations do not permit LRT vehicles to operate in mixed service with inter-city passenger trains unless provisions are made to assure a means of positive separation from such trains. Provisions could include measures such as a dedicated track within the corridor and the use of an intervening crash wall or temporal separation. Power requirements for LRT and electrified inter-city passenger rail require different electrical service and are incompatible with one another.

The design criteria presented in this document are based on the I-664/I-564 alignment for the rail component of the HR3X and do not include consideration of a connection to the south end of the I-664 harbor crossing in the vicinity of Tidewater Community College. Limited transit uses have been identified in this area.

B. Diesel Multiple Units

1. Vehicle Description

Diesel multiple units, or DMUs, are self-propelled passenger cars. These units, as based on the design being developed by Colorado Rail Car of Ft. Lupton, CO and as would be available in single or bi-level configurations. These units have the option of an aerodynamic or squared end and glass domed roofs. The overall size of the vehicle is 85-feet long and 10-feet wide. Overall vehicle height above top of rail for the single level car would be 14-feet 1-inch and would be 18-feet for the bi-level vehicle. Seating capacity for a three-car, single level DMU consist would be 246 persons but would be reduced to 228 if the glass-domed roof were selected. A two-car bi-level DMU consist could seat 370 passengers. The single level units have a continuous level floor that is 51-inches above the top of rail. The bi-level units have a low level entrance that is 18-inches above the top of the rail. For both vehicles, the step height at the vehicle entrance is 18-inches above the top of the rail.

The Colorado Rail Car DMU units are equipped with control cabs at one end of the car. Cars are air-conditioned and have ADA compliant lavatories. Entrances consist of a set of bi-parting doors located in the center of the car on each side. Vehicles would have intercommunications capabilities. The empty weights of a single and bi-level unit are 148,000 lbs and 163,000 lbs, respectively, with single and bi-level, non-powered trailers also available. Trailers have low-level entrance floors and can be equipped with a cab and controls with seating and unit amenities identical to that of a power equipped unit. Empty weights would be 142,000 lbs and 157,000 lbs for the single and bi-level trailers, respectively.

2. Performance Characteristics

DMUs have the power capability to pull a passenger trailer. Possible train consists would be one power unit and two trailers, two power units and three trailers, or one power unit and a bi-level trailer. Two 600 hp diesel motors would supply vehicular power with each motor having an independent direct drive to one of the two wheel trucks. The Colorado Rail Car, as currently designed, is capable of a maximum operating speed of 90 mph. It is assumed for the purposes of this study that DMU rail cars marketed by other manufacturers would also be considered for service if such vehicles were certified to be FRA-compliant at the time the project enters the design stage.

3. Potential Operations Scenario

Peak headways for DMU service are projected at between 15 and 30 minutes through the crossing. It is anticipated that FRA-compliant DMU vehicles may operate in mixed-use with inter-city passenger trains on the HR3X and potentially with freight trains on other portions of the HRT system.

C. Light Rail Transit

1. Vehicle Description

Light rail transit vehicles as considered for the HR3X would be articulated vehicles consisting of a minimum of two main passenger compartments. The passenger compartments would be joined to form a single operating unit (married pair). Each vehicle would have a fully equipped operator's cab at each end and could be operated in either direction. Vehicles could be operated as a single unit, or in combination of two to six vehicles. HRT's current plan is to operate a single vehicle. The vehicles would use a low floor design to allow simple boarding from station platforms. The low floor profile would continue through the articulated section of the vehicle that joins the two compartments. Forward ends of the vehicle would have raised floors in order to accommodate the vehicle's trucks. The vehicle would be air-conditioned.

The overall size of the LRT vehicle would be 90-feet long, 9-feet wide, and have a height of 12 to 13-feet above the top of rail, exclusive of the pantograph. There would be four exits from the vehicle, two per side, located within the low floor area. Doors would be bi-parting. The vehicle would have radio, public address, and intercommunications capability. Capacity of the vehicle would be approximately 290 persons with three-quarters of the riders standing. The design loading at full capacity would be approximately 133,000 lbs.

2. Performance Characteristics

The LRT vehicle is capable of a maximum speed between 55 and 65 mph. Power would be supplied by an overhead catenary system and the vehicle would operate over the range of 450 to 950 volts DC power. Peak headways are planned at 15 minutes through the crossing.

3. Incompatibility with Railroad Service

Hampton Roads Transit has not completed a detailed study of transit operations through the HR3X. LRT vehicles have not been eliminated from consideration for use within the HR3X. However, FRA regulations do not permit LRT vehicles to operate in mixed service with inter-city passenger trains unless provisions are made to assure a means of positive separation from such trains. Provisions could include measures such as a dedicated track within the corridor and the use of an intervening crash wall. Another provision, temporal separation, would be a designation of periods of time during which only one particular type of equipment would be allowed use of specific sections of the corridor. Traffic control points generally delineate section limits. Overhead catenary power requirements for LRT and electrified inter-city passenger rail require different electrical service and are incompatible with one another.

4. Additional Considerations - Fire and Life Safety

Fire and life safety provisions for transit facilities are governed by the specifications of the National Fire Protection Association NFPA 130 Specifications for Fixed Guideway Facilities. Some of the specific NFPA 130 specified tunnel safety provisions include use of a safety walkway, tunnel crosspassage connections spaced at a maximum of 800-ft intervals protected with fire door assemblies, tunnel ventilation requirements, tunnel lighting, blue-light emergency communication facilities, and a dry standpipe fire line connection. Other safety considerations would be required as well and would need to be evaluated during the preliminary design stages of the project.

Tunnel safety provisions for railroad operations may be found in the FRA 1990 report "Tunnel Safety Analysis." The 1990 FRA Tunnel report is not a published guideline or regulatory document but is distributed to Amtrak and other railroads. The FRA worked with the railroads to make improvements as suggested in the report.

Additional requirements found in 49 CFR 239 "Passenger Train Emergency Preparedness" require an emergency preparedness plan be prepared at least 45 days prior to commencing any new passenger operations. In addition, 49 CFR 239.101 (4) delineates some emergency preparedness requirements for tunnels.

Provisions of the federal statute 49 CFR 238.103 (d) (3) (i) require a "complete fire safety analysis for all categories of equipment and service" be developed for railroads operating existing passenger equipment. Adherence to provisions of these regulations would apply to Amtrak.

There are also regulatory requirements for the safety analysis of new equipment being introduced for passenger service. On June 25, 2002, the FRA published an amendment to 49 CFR 238.103 (c). The amendment states in part, "each railroad shall ensure that fire safety considerations and features in the design of this equipment reduce the risk of personal injury caused by fire to an acceptable level in its operating environment." These provisions would apply to the operator of any passenger rail or DMU service. The American Public Transportation Association (APTA) document "Recommended Practice for Fire Safety Analysis of Existing Passenger Rail Equipment" (RP-PS-005-00) is acceptable to the FRA as a technique to implement 49 CFR 238.103.

The provisions of NFPA 130 are consistent with the FRA guidance outlined in the 1990 report and meet FRA concerns outlined at that time for long tunnels. The provisions of NFPA 130 can be used to assist the operating railroad(s) to comply with 49 CFR 238 and 239 requirements.

Operation of diesel powered vehicles within the tunnel requires adequate ventilation equipment to ensure lowered levels of carbon monoxide during normal operation. A design analysis of the emissions within the tunnel portions of the HR3X, compliant with American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) requirements, is recommended during development of the ventilation system design.

In addition, fan size and air handling capacities need to be designed to provide recommended levels of safety in the event of a vehicle fire consistent with applicable code requirements. The potential safety issues associated with transporting large volumes of diesel fuel need to be recognized as well. Although FRA vehicle specifications address fuel tank safety issues, explosive material potential should be reasonably assessed in the design of tunnel-confined spaces.

"Roadway Worker Protection" (49 CFR 214 Subpart C) covers railroad maintenance worker requirements. One particular requirement that needs to be evaluated is a provision to provide four feet of clearance to the field side of a near running rail so that an employee is permitted a safety zone adjacent a passing train. Based on the proposed clearance envelope within the 3rd crossing, and as a general safety consideration, staff would only be allowed to work in the tunnel with absolute possession and when protected by a stationary vehicle.

5. Miscellaneous Issues

Provisions should be included to provide for the design of possible derailment loads associated with rail and transit vehicles on the structure. Bridge superstructures are to be designed to support possible steel wheel derailment point loads to ensure overall stability of the structure. Design is to be in accordance with the American Railway Engineering and Maintenance of Way Association (AREMA) Manual of Railway Engineering.

Additional consideration shall be given to providing a concrete exterior walkway on the structure. The top of the walkway is recommended to be level with the top of the rail and be designed to accommodate 10% of the vertical wheel load applied as a lateral load.

Concurrent light rail transit and inter-city passenger rail service on adjacent tracks will require a barrier crash wall between the tracks. The wall is to be designed to ensure separation of the vehicle types in the event of a derailment. No formal crashwall design criteria has been developed. Crashwall evaluation is to be determined in final design.

6. Design Criteria

A matrix of design criteria titled Hampton Roads 3rd Harbor Crossing Rail Criteria was compiled listing various rail attributes to be considered in the design of the bridge and tunnel. The matrix shows the design parameters to be used for rail attributes for the four different modes of rail transit being considered. The four rail transit modes are:

1. Light rail transit
2. Diesel multiple units
3. Amtrak inter-city service
4. Amtrak high-speed service

Additionally, the stakeholders requested that design parameters be determined in the event a combination of transit modes is selected as the final configuration. The two combinations were specified as (1) light rail transit/ Amtrak inter-city passenger service, and (2) diesel multiple units/Amtrak inter-city passenger service. The design parameters for those two combinations are shown in the matrix.

The design parameters in the matrix were determined based on the operating scenarios and attributes of the four transit modes under consideration. The specified parameter values were obtained from various sources of information and specifications that dealt with the specific mode under consideration. The sources consisted of:

- Transit and inter-city passenger rail system owners and operators such as Hampton Roads Transit and Amtrak.
- Equipment manufacturers such as Bombardier and Colorado Railcar Manufacturing, LLC.
- Publishers of recommended guidelines and practices applicable to the rail attributes, such as AREMA and the National Fire Protection Association.

Once the design parameters were determined for each attribute for each rail and transit mode, the parameters were determined for the two controlling mode combinations. These combined mode parameters were determined by comparing the parameters for the individual modes. The most restrictive parameter of the two individual modes was then specified as the parameter of the combined modes. Any special condition for a specific parameter or attribute is given in a note at the bottom of the matrix.

The parameters listed were determined using the following assumptions:

- The Controlling Criteria shown will be used for the design of the multi-modal/rail portions of the Hampton Roads 3rd Crossing.
- The geometric design of connections to any existing rail lines at the approaches to the crossing were not developed.
- HR3X rail operational speed would be 79 mph or less.
- Any high-speed train sets would not travel at high speed in any portion of the tunnel or bridge. AREMA defines high speed as 80 to 125 mph.
- The rail route alignment on the bridge and in the tunnel will run parallel with I-664 from Newport News, turn eastward and parallel with I-564, and parallel the eastern I-564 approach in the area of the Norfolk International Terminal.

It is recommended that the facility design and review include experienced rail and transit engineering staff. The governing design code for structural engineering of the rail component of the project should be the AREMA Manual for Railway Engineering, latest edition. Finally, applicable design standards should be reviewed again if a substantial amount of time lapses prior to project advancement.

* * *

APPENDIX A

HAMPTON ROADS 3RD HARBOR CROSSING

RAIL DESIGN CRITERIA

HAMPTON ROADS 3rd HARBOR CROSSING RAIL DESIGN CRITERIA

<table>
<tr><th></th><th></th><th></th><th></th><th></th><th colspan="2">COMBINED SYSTEM CONTROLLING CRITERIA</th></tr>
<tr><th>Track Geometry</th><th>Hampton Roads Transit
Light Rail Transit</th><th>Hampton Roads Transit
Diesel Multiple Units - DMU</th><th>Amtrak
Inter-City Passenger Rail</th><th>Amtrak
High Speed Passenger Rail</th><th>Light Rail Transit &
Inter-City Passenger Rail</th><th>Diesel Multiple Units - DMU &
Inter-City Passenger Rail</th></tr>
<tr><td>Maximum horizontal curvature/minimum curve radius
see Note 1</td><td>D=19° 05' / 300 feet (@ grade ballasted) (c)
D=57° 17' / 100 feet (in street desired) (c)
Radius 82 feet (in street absolute) (c)</td><td>D= 22° 55' / 250 feet (a) (f)</td><td>D=10° / 570 feet (d)</td><td>D=11° 30' / 500 feet (b)
D=10° / 570 feet (d)</td><td>D=10° / 570 feet (absolute limit) (d)
D= 3°-30' / 1640 feet (desired limit) (d)</td><td>D=10° / 570 feet (absolute limit) (d)
D=3°-30' / 1640 feet (desired limit) (d)</td></tr>
<tr><td>Required tangent lengths between reverse curves
see Note 15</td><td>200 feet (desired) (c)
greater of 100 ft or (c)
3 x design speed "mph" (minimum)
40 ft (absolute minimum w/ HRT approval) (c)</td><td>Greater of 100 feet or (g)
Lmin =3 x velocity "mph" (d)
for passenger rail</td><td>Greater of 100 feet or (g)
Lmin =3 x velocity "mph"
for passenger rail</td><td>Greater of 100 feet or (g)
Lmin =3 x velocity "mph" (d)
for passenger rail</td><td>Minimum: Greater of 100 feet or (g)
Lmin =3 x velocity "mph" (d)
Desired: Greater of 200 feet or (c)
Lmin =3 x velocity "mph" (d)</td><td>Minimum: Greater of 100 feet or (g)
Lmin =3 x velocity "mph" (d)
Desired: Greater of 200 feet or (c)
Lmin =3 x velocity "mph" (d)</td></tr>
<tr><td>Superelevation requirements</td><td>Eq (in) = Ea +Eu = 3.96(V^2)/R (c)
Ea = 2.64(V^2)/R - 0.67 (c)
Desirable max. - Ea max = 4" Eu max = 3" (c)
V - "mph" R - "ft"</td><td>Ea = 0.0007(V^2)D (d)
Ea max=6" (d) (h)
Eu of 2.5 - 4.75 inches (d) (note 2)</td><td>Ea = 0.0007(V^2)D (d)
Eu of 2.5 - 4.75 inches (d) (note 2)
Eu max = 3 inches (h)</td><td>Ea = 0.0007(V^2)D (d)
Eu of 2.5 - 4.75 inches (d) (note 2)
Up to 9 inches Eu for tilt equipment (b)</td><td>Ea = 0.0007(V^2)D (d)
Ea max=4 inches (c)
Max. Eu of 2.5 - 3 inches (d) (g) (</td><td>Ea = 0.0007(V^2)D (d)
Ea max=6 inches (d) (g)
Max. Eu of 2.5 - 3 inches (d) (g) (</td></tr>
<tr><td>Spiral length requirements</td><td>Greater of: Ls = 1.10EaV
Ls = 0.82EuV
Ls = 31Ea
60 ft (c)</td><td>Lmin = 1.63EuV (d)
Lmin = 1.22EuV when above is costly (d)
Greater of LS=62Ea (V<50) (g)
Ls=83Ea (50<V<70) Ls=124Ea (70<V<125)
and, when D<1°30'</td><td>Lmin = 1.63EuV (d)
Lmin = 1.22EuV when above is costly (d)
Greater of LS=62Ea (V<50) (g)
Ls=83Ea (50<V<70) Ls=124Ea (70<V<125)
and, when D<1°30'</td><td>Lmin = 1.63EuV #1
Lmin = 62 Ea for tilt equipment #2
Lmin = 1.22EuV when #1 is costly #3
use the greater of #1 & #2 or #2 & #3 (d)
Greater of LS=62Ea (V<50) (g)
Ls=83Ea (50<V<70) Ls=124Ea (70<V<125)
and, when D<1°30'</td><td>Lmin = 1.63EuV (desired) (d)
Lmin = 1.22EuV (minimum) (d)
Greater of LS=62Ea (V<50) (g)
Ls=83Ea (50<V<70) Ls=124Ea (70<V<125)
and, when D<1°30'</td><td>Lmin = 1.63EuV (desired) (d)
Lmin = 1.22EuV (minimum) (d)
Greater of LS=62Ea (V<50) (g)
Ls=83Ea (50<V<70) Ls=124Ea (70<V<125)
and, when D<1°30'</td></tr>
<tr><td>Maximum grade - inside tunnels</td><td>4% (c)
7% max for short sustained grade (c)
4% (f)</td><td>4% (f)</td><td>4% acceptable (h)
(2 - 2.5% for less operational cost) (h)
<=2.5% (g)</td><td>3 - 3.25% from rest @ 75% traction (b)
4% @ speed</td><td>4% (c) (h)</td><td>4% (c) (h)</td></tr>
<tr><td>Maximum grade - outside tunnels</td><td>4% (c)
7% max for short sustained grade (c)
4% (f)</td><td>4% (f)</td><td>4% acceptable (i)
(2 - 2.5% for less operational cost) (i)
<=2.5% (h)</td><td>3 - 3.25% from rest @ 75% traction (b)
4% @ speed</td><td>4% (c) (h)</td><td>4% (c) (h)</td></tr>
<tr><td>Length of vertical curve/ minimum radius, for crests</td><td>Lmin = 200A desirable (c)
Lmin = 100A preferred (c)
Lmin = (A x V^2)/45 minimum (c)
Rmin = 820 ft A=|G2-G1| (f)</td><td>2000 ft. minimum radius (a) (g)</td><td>Lmin = (DV^2K)/A (note 3) (d)
D=|G2-G1| K=2.15 "ft"
A=0.60 ft/sec-sec (passenger)
Lmin=|G2-G1|/0.0095 (i)</td><td>2000 ft minimum vertical curve length (b)
Lmin = (DV^2K)/A (note 3) (d)
D=|G2-G1| K=2.15 "ft"
A=0.60 ft/sec-sec (passenger)
Lmin=|G2-G1|/0.0095 (i)</td><td>Lmin=|G2-G1|/0.0095 (i)</td><td>Lmin=|G2-G1|/0.0095 (i)</td></tr>
<tr><td>Length of vertical curve/ minimum radius, for sags</td><td>Lmin = 200A desirable (c)
Lmin = 100A preferred minimum (c)
Lmin = (A x V^2)/45 absolute minimum (c)
Rmin = 820 ft A=|G2-G1| (f)</td><td>2000 ft. minimum radius (a) (g)</td><td>Lmin = (DV^2K)/A (note 3) (d)
D=|G2-G1| K=2.15 "ft"
A=0.60 ft/sec-sec (passenger)
Lmin=|G2-G1|/0.0095 (i)</td><td>2000 ft minimum vertical curve length (b)
Lmin = (DV^2K)/A (note 3) (d)
D=|G2-G1| K=2.15 "ft"
A=0.60 ft/sec-sec (passenger)
Lmin=|G2-G1|/0.0095 (i)</td><td>Lmin=|G2-G1|/0.0095 (i)</td><td>Lmin=|G2-G1|/0.0095 (i)</td></tr>
<tr><td>Required length of constant grade between vertical curves</td><td>Greater of: 100 feet or 3 x V (c)</td><td>Greater than 100 ft (general)
Lmin = 3 x V for pass. rail transit (d)</td><td>Greater than 100 ft (general)
Lmin = 3 x V for pass. rail transit (d)</td><td>Greater than 100 ft (general)
Lmin = 3 x V for pass. rail transit (d)</td><td>Greater of: 100 feet or 3 x V (c)</td><td>Greater of: 100 feet or 3 x V (c)</td></tr>
</table>

Data sources
a: Colorado Railcar Manufacturing, LLC
b: Bombardier Transportation - indicates Acela Express equipment capabilities
c: Hampton Roads Transit Functional Design Criteria - June, 2002
d: AREMA
e: Norfolk-Southern reply to AASHTO/NSBA Steel Bridge Collaboration
f: Hampton Roads Transit Tunnel Design Criteria Correspondence - June 25,2002
g: Amtrak MW1000
h: Amtrak letter of 3/27/02 and meeting of 9/20/02
i: Amtrak direction per meeting of 12/03/02

Note 1: Degree of curve, D, expressed as arc definition.
Note 2: FRA approval required for underbalanced elevation greater than 4 inches.
Note 3: Consider as absolute minimum, longer curve is desirable if possible.
Note 15: TTDC - Tidewater Transportation District Commission

HAMPTON ROADS 3rd HARBOR CROSSING RAIL DESIGN CRITERIA

Track Structure	Hampton Roads Transit Light Rail Transit		Hampton Roads Transit Diesel Multiple Units - DMU		Amtrak Inter-City Passenger Rail		Amtrak High Speed Passenger Rail		COMBINED SYSTEM CONTROLLING CRITERIA: Light Rail Transit & Inter-City Passenger Rail		COMBINED SYSTEM CONTROLLING CRITERIA: Diesel Multiple Units - DMU & Inter-City Passenger Rail	
Track gauge	4 ft - 8½ in		4 ft - 8½ in		4 ft - 8½ in		4 ft - 8½ in		Standard Gauge of 4 ft - 8½ in for all modes to ensure compatability			
Rail weight	115 # RE CWR	(c)	115 #, 119 #, 132 #, 133 #, 136 #, 140 #, 141 # see note 4	(d)	115 #, 119 #, 132 #, 133 #, 136 #, 140 #, 141 # see note 4	(d)	115 #, 119 #, 132 #, 133 #, 136 #, 140 #, 141 # see note 4	(d)	115 #, 119 #, 132 #, 133 #, 136 #, 140 #, 141 # see note 4	(d)	115 #, 119 #, 132 #, 133 #, 136 #, 140 #, 141 # see note 4	(d)
Rail Support System	For ballasted section - timber and concrete ties (c) For ballasted special track work - timber ties (c) Direct fixation may be specified (c)		For ballasted section - timber and concrete ties (c) For ballasted special track work - timber ties (c) Direct fixation may be specified (c)		All track on structure and in tunnel to be direct fixation.	(h)	All track on structure and in tunnel to be direct fixation.	(h)	All track on structure and in tunnel to be direct fixation.	(h)	All track on structure and in tunnel to be direct fixation.	(h)
Controlling design standards for special track facilities including turnouts, cross-overs, track crossings	AREMA Manual (see note 8)	(c)	AREMA Manual (see note 8)	(d)	AREMA Manual (see note 8)	(d)	AREMA Manual (see note 8)	(d)	AREMA Manual (see note 8)	(d)	AREMA Manual (see note 8)	(d)
Turnout size	High speed - #20 & #15 Intermediatespeed - #10 & #8 Low speed - #6	(c)	#15 or greater	(f)	#20 and greater	(g)	#20 and greater	(g)	#20 desirable (g) #15 mimimum (f)		#20 desirable (g) #15 mimimum (f)	

Data sources
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h: Amtrak letter of 3/27/02 and meeting of 9/20/02
i: Amtrak direction per meeting of 12/03/02

Note 4: Rail section to be selected dependant on tonnage and track geometry.
Note 8: AREMA publishes "Recommended Practices", actual criteria to be established by owner and/or operator.

HAMPTON ROADS 3rd HARBOR CROSSING RAIL DESIGN CRITERIA

Operations	Hampton Roads Transit Light Rail Transit	Hampton Roads Transit Diesel Multiple Units - DMU	Amtrak Inter-City Passenger Rail	Amtrak High Speed Passenger Rail	COMBINED SYSTEM CONTROLLING CRITERIA Light Rail Transit & Inter-City Passenger Rail	COMBINED SYSTEM CONTROLLING CRITERIA Diesel Multiple Units - DMU & Inter-City Passenger Rail
Maximum operational designated speed **See notes 5 & 9**	65 mph (c)	Max. operating speed 90 mph (a) 50-80 mph (d)	80 mph assumed on performance study (h) Max operating speed=79 mph (d)	200 mph (note 7) (h) 150 mph (b) 80-125 mph (d)	Light Rail line - 65 mph (c) Inter-City Pass. - 79 mph operating speed (i) (See notes 10 & 11)	Max. operating speed 79 mph (a)
Motive power source	Electric overhead catenary Substations 1-1.5 mile intervals 12.5-37.5 Kvolts AC. 3p, 60Hz, 750 dc (c)	Two 600 hp diesel engines per car (a)	From performance study: (h) Two fully functioning diesel GE P42 Acela would possibly be electrified. Future electrification to be considered.	Two locomotives One/two fossil fuel power car and/or one electric power (b) Future electrification to be considered.	Power source determined by mode selection	Power source determined by mode selection
Train consist	1 - 2 - 3 -----> 6 units (c) 1 articulated vehicle (f)	2 back to back cab units (f) 2 power cars (c) 2 power cars and 1 trailer (a) 4 power cars and 2 trailers (a)	Locomotive with 4 to 8 cars (h) Low level fleet	One fossil fuel power car and one electric power car with 6 passenger cars (b)	Consists unique to mode: LRT: 1 - 2 - 3 -----> 6 units (c) Inter-City: Locomotive with 4 to 8 cars (h) Low level fleet	Consists unique to mode: DMU: 2 - 6 cars Inter-City: Locomotive with 4 to 8 cars (h) Low level fleet
Frequency/hours of operation	6:00 am - 1:00 am Mon - Fri 6:00 am - 1:00 am Sat 8:00 am - Midnight Sun @ 10 - 20 - 30 minute intervals (c)	6:00 am - 1:00 am Mon - Fri 6:00 am - 1:00 am Sat 8:00 am - Midnight Sun @ 10 - 20 - 30 minute intervals (c)	4, 6, 8, 10 trains per day - both directions (h) Currently: 2 to Newport News daily 2 from Newport News daily	4, 6, 8, 10 trains per day - both directions (h) Currently: 2 to Newport News daily 2 from Newport News daily	Frequency and hours of operation for each mode independent due to separation of mode operations. (See notes 10)	Would require scheduling of inter-city service within schedule of rapid transit system operating on constant, frequent schedule by time blocks or track assignment
System design life	Continued operation for 50 years (c)	Continued operation for 50 years (c)	Traffic and service levels anticipated at 15 - 20 years into the future (d)	Traffic and service levels anticipated at 15 - 20 years into the future (d)	Continued operation for 50 years (c) Traffic and service levels anticipated at 15 - 20 years into the future (d)	Continued operation for 50 years (c) Traffic and service levels anticipated at 15 - 20 years into the future (d)
Equipment design loads	Cooper - E80 railroad loading (c) Car wt. = 132,627# (c) Car wt = 185,000# (f)	390,000# - 2 units (c) (f) Car wt = 148,000 #- 163,000# (a) Fuly loaded - 180,000# - 215,000#	Cooper - E60 (h) passenger only structure designation	Cooper - E60 (h) passenger only structure designation	Fully loaded transit car wt = 185,000# (f) Cooper - E60 : passeng. only structure (h)	390,000# - 2 units (c) (g) Fuly loaded - 180,000# - 215,000# (a) Cooper - E60 (h) passenger only structure designation
Miscellaneous equipment	Provisions for signal, catenary, and wayside equipment attachment to be considered.	Provisions for signal, catenary, and wayside equipment attachment to be considered.	Provisions for signal, catenary, and wayside equipment attachment to be considered.	Provisions for signal, catenary, and wayside equipment attachment to be considered.	Provisions for signal, catenary, and wayside equipment attachment to be considered.	Provisions for signal, catenary, and wayside equipment attachment to be considered.

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f: Hampton Roads Transit Tunnel Design Criteria Correspondence - June 25,2002
g: Amtrak MW1000
h: Amtrak letter of 3/27/02 and meeting of 9/20/02
i: Amtrak direction per meeting of 12/03/02

Note 5: AREMA defines:
Low speed 0-59 mph
Moderate speed 60-79 mph
High speed 80-125 mph

Note 7: Operating speeds in excess of 150 mph are authorized only in conjunction with a rule of particular applicability addressing other safety issues presented by the system (Amtrak MW1000)

Note 9: Maximum operational designated speed refers to maximum vehicular authorized speed and is not necessarily the design or operating speed on the bridge or within the tunnel, except as noted.

Note 10: Light rail equipment and Inter-City equipment would operate on dedicated tracks and not use the same track.

Note 11: Each mode would operate at its equipment design speed.

HDR

HAMPTON ROADS 3rd HARBOR CROSSING RAIL DESIGN CRITERIA

Clearances & Offsets	Hampton Roads Transit Light Rail Transit	Hampton Roads Transit Diesel Multiple Units - DMU	Amtrak Inter-City Passenger Rail	Amtrak High Speed Passenger Rail	COMBINED SYSTEM CONTROLLING CRITERIA Light Rail Transit & Inter-City Passenger Rail	COMBINED SYSTEM CONTROLLING CRITERIA Diesel Multiple Units - DMU & Inter-City Passenger Rail
Minimum track centers	14' - 0" ballast with center poles (c) 12' - 0" ballast without center poles (c) 13' - 6" direct fixation with center poles (c) 11' - 6" direct fixation without center poles (c)	14' - 0" based on local freight railroad and Amtrak standard	14' - 0" adjacent main, yard, indust., & other (g) side tracks. (note 13)	26 feet to adjacent freight track (e) when operating at maximum speed	See note 10 Not applicable	15' - 0" min. track centers See notes 12, 13, & 14
Minimum horizontal clearance to adjacent structure See note 6	9' - 0" (c)		9' - 0" tangent track (d) Refer to AREMA Chapter 28 Sect. 1 (d) for additional tunnel clearance requirements 16' - 0" to permanent structures (g) owned by others	9' - 0" tangent track (d) Refer to AREMA Chapter 28 Sect. 1 (d) for additional tunnel clearance requirements 16' - 0" to permanent structures (g) owned by others	9' - 0" tangent track (d) Refer to AREMA Chapter 28 Sect. 1 (d) for additional tunnel clearance requirements See note 6	9' - 0" tangent track (d) Refer to AREMA Chapter 28 Sect. 1 (d) for additional tunnel clearance requirements See note 6
Minimum vertical clearance from top of high rail See Note 16	19' - 6" preferred (c) 15' - 0" desired (c) 14' - 3" absolute (c)	Car height = 18' bi-level, 13' - 7" single level (a) (c)	19' preferred (h) 17' - 6" minimum (h) 16' - 10" overhead wire (h) 23' at track centerline (d)	19' preferred (h) 17' - 6" minimum (h) 16' - 10" overhead wire (h) 23' at track centerline (d)	Clearance to overhead soffit: 19' - 6" preferred (c) 17' - 6" minimum (h)	Clearance to overhead soffit: 19' preferred (h) 17' - 6" minimum (h)

Data sources
a: Colorado Railcar Manufacturing, LLC
b: Bombardier Transportation - indicates Acela Express equipment capabilities
c: Hampton Roads Transit Functional Design Criteria - June, 2002
d: AREMA
e: Norfolk-Southern reply to AASHTO/NSBA Steel Bridge Collaboration
f: Hampton Roads Transit Tunnel Design Criteria Correspondence - June 25,2002
g: Amtrak MW1000
h: Amtrak letter of 3/27/02 and meeting of 9/20/02
i: Amtrak direction per meeting of 12/03/02

Note 6: On curved track, clearance on each side should be increased by 1 1/2 inches for each degree of curve. (AREMA Manual for Railway Engineering & Amtrak MW1000) Additionally, inside clearance for superelevated track increased further by 1 inch at each 5 feet interval above top of low rail for each inch of actual superelevation. (Amtrak MW1000)
Note 10: Light rail equipment and Inter-City Passenger equipment would operate on dedicated tracks and not use the same track. This operation separation would require a crash wall to separate the two modes.
Note 12: 15'-0" minimum track centers recommended for increased safety.
Note 13: Track center specified is for tangent track and should be increased for curves in accordance with MW1000 62.1 (d)
Note 14: Track centers conditional on DMU equipment meeting FRA specifications for mixed freight usage.
Note 16: Clearance refers to underside of structure and provides sufficient space for overhead catenary operation.

HAMPTON ROADS 3rd HARBOR CROSSING RAIL DESIGN CRITERIA

Emergency Considerations	Hampton Roads Transit Light Rail Transit	Hampton Roads Transit Diesel Multiple Units - DMU	Amtrak Inter-City Passenger Rail	Amtrak High Speed Passenger Rail	COMBINED SYSTEM CONTROLLING CRITERIA: Light Rail Transit & Inter-City Passenger Rail	COMBINED SYSTEM CONTROLLING CRITERIA: Diesel Multiple Units - DMU & Inter-City Passenger Rail
Minimum width evacuation paths	NFPA 130 requirements 48 inch desirable 30 inch minimum (c) ADA Standards to be considered	NFPA 130 requirements	NFPA 130 requirements	NFPA 130 requirements	NFPA 130 requirements with 3' - 6" emergency walkway recommended	NFPA 130 requirements with 3' - 6" emergency walkway recommended
Midway pedestrian crossover	NFPA 130 requirements (minimum spacing = 800 ft.) ADA Standards to be considered	NFPA 130 requirements (minimum spacing = 800 ft.) ADA Standards to be considered	NFPA 130 requirements (minimum spacing = 800 ft.) ADA Standards to be considered	NFPA 130 requirements (minimum spacing = 800 ft.) ADA Standards to be considered	NFPA 130 requirements (minimum spacing = 800 ft.) ADA Standards to be considered	NFPA 130 requirements (minimum spacing = 800 ft.) ADA Standards to be considered
Ventilation	ASHRAE requirements NFPA 130 requirements	ASHRAE requirements NFPA 130 requirements FRA requirements	ASHRAE requirements NFPA 130 requirements FRA requirements	ASHRAE requirements NFPA 130 requirements FRA requirements	ASHRAE requirements NFPA 130 requirements FRA requirements	ASHRAE requirements NFPA 130 requirements FRA requirements
Fire	NFPA 130 requirements (c)	NFPA 130 requirements (d) FRA guidelines	NFPA 130 requirements (h) FRA guidelines	NFPA 130 requirements (h) FRA guidelines	NFPA 130 requirements FRA guidelines	NFPA 130 requirements FRA guidelines
Right-of-way encroachment detection	Closed circuit TV. (c)	Not considered	Not considered	Not considered	Closed circuit TV monitoring to be considered	Closed circuit TV monitoring to be considered
Midway universal track crossover	Not considered	Not considered	Not considered	Not considered	Should be considered in the event of line blockage or emergency situation, and for maintenance purposes.	Should be considered in the event of line blockage or emergency situation, and for maintenance purposes.

Data sources
a: Colorado Railcar Manufacturing, LLC
b: Bombardier Transportation - indicates Acela Express equipment capabilities
c: Hampton Roads Transit Functional Design Criteria - June, 2002
d: AREMA
e: Norfolk-Southern reply to AASHTO/NSBA Steel Bridge Collaboration
f: Hampton Roads Transit Tunnel Design Criteria Correspondence - June 25,2002
g: Amtrak MW1000
h: Amtrak letter of 3/27/02 and meeting of 9/20/02
i: Amtrak direction per meeting of 12/03/02

APPENDIX B

DRAFT DESIGN BASIS MEMORANDUM

COMMENTS AND RESPONSES

HRT
Hampton Roads Transit
3400 Victoria Boulevard, Hampton, Virginia 23661
Phone: 757-222-6000 ~ Southside Fax: 757-222-6103
Peninsula Fax: 757-222-6195 ~ www.hrtransit.org

February 13, 2003

Mr. William J. Novak
Project Manager
1101 King Street, Suite 400
Alexandria. VA 22314 2944

Subject: **Comments to Hampton Roads Third Crossing, Technical Memorandum No.2 – Design Basis**

Dear Mr. Novak:

Please find attached our comments on the draft Technical Memorandum No. 2 that you sent us for review and comment on January 17, 2003. Should you wish to discuss the comments you may call Les Durrant, our Director of Engineering, on (757) 222 6000 X 6026.

We appreciate you seeking our input.

Sincerely,

Jayne B Whitney

Jayne B. Whitney
Chief Development Officer
Hampton Roads Transit

Distribution:

Les Durrant
John Coard

HRT COMMENT SHEET

Name: Hampton Roads Transit **Date:** February 5, 2003

Report Name: Hampton Roads Third Crossing Technical Memorandum No.2-Design Basis Memorandum Dated January 2003

Com	Section	Paragraph	Line/ Comment	Disposition
1	Figure 1		Chesapeake is not shown on the map	
2	4	5	Current NFPA Requirements (2000) Section 3.2.4 appears to require cross passengers every 800 ft unless there is an exit to the surface where cross passengers	
3	4,Page 19	third line	To minimize the size of the tunnel and as a general safety consideration staff would only be allowed to work in the tunnel with absolute possession and when protected by a stationary vehicle.	
4	Last Page-		Using a 3'6" walkway "as standard" could set a precedent for other railways to follow, with corresponding significant cost impacts on tunnel diameters. A design philosophy here could be to get the passengers off the walkway on to track level as soon as practicable reducing the risk of falling and this approach will wider evacuation path.	
5	General		Unless there is another evacuation scenario each of the tracks need to be fire separated with fire rated doors between the track-ways at the cross passages. The adjacent track-way then provides an area of safe refuge where patrons can be picked up. The separation of the tracks also helps with the ventilation during a fire.	
6			Because the Amtrak service is very limited, single tracking with appropriate Signaling could be a viable, cost saving option in the tunnel section if it is planned to provide a separate Amatrak Row in the tunnels.	
7			What are the projected lengths and locations of the tunnels and bridge sections of the Third Crossing:	
8				

HAMPTON ROADS THIRD HARBOR CROSSING
Technical Memorandum No. 2

Responses to Hampton Roads Transit Comments
Dated: February 13, 2003
Prepared by: Jayne B. Whitney

No.	Document Location	Comment
1.	Figure 1	Chesapeake is not shown on the map.

Response: Maps and drawings associated with the project and area show Chesapeake labeled as below the I-64 loop. Chesapeake will be shown on Fig 1.

2.	Pg 18 Section 4	Current NFPA Requirements (2000) Section 3.2.4 appears to require cross passageways every 800 ft unless there is an exit to the surface.

Response: Crosspassage spacing will be revised. Per NFPA 130, cross passageways between tunnels are to be spaced no farther than 800 ft with fire door assemblies having a rating of 1½ hours.

3.	Pg 19 Paragraph 8 Last line	To minimize the size of the tunnel and as a general safety consideration, staff would only be allowed to work in the tunnel with absolute possession and when protected by a stationary vehicle.

Response: Safety walkways are provided for emergency evacuation and are not intended as work platforms. HRT comment included in text.

4.	Emergency Considerations Matrix - Min. width evacuation paths	Using a 3'6" walkway "as standard" could set a precedent for other railways to follow, with corresponding significant cost impacts on tunnel design. A design philosophy here could be to get the passengers off the walkway on to track level as soon as practicable reducing the risk of falling and this approach will widen the evacuation path.

Response: Evacuation paths will also need to provide enough room to extract and transport any injured passengers from the transit vehicles. The desired time to evacuate the passengers from a disabled train, and the number of passengers riding the train will directly affect the evacuation path width. NFPA 130 has no emergency egress requirements specific to the trainways other than providing a suitable method for evacuating passengers in an uncontaminated trainway, for protecting passengers from oncoming traffic and for evacuating the passengers to a nearby station or other emergency exit. There are specifics in NFPA 130 relating to station egress, which is to be based on emergency conditions and the evacuation of the train(s) and station occupants. Additionally, in the event of a blockage of the evacuation path by train equipment, a wider path along the side of the tunnel would increase the chance of passengers being able to go around the blockage.

5. General — Unless there is another evacuation scenario each of the tracks need to be fire separated with fire rated doors between the track-ways at the cross passages. The adjacent track-way then provides an area of safe refuge where patrons can be picked up. The separations of the tracks also helps with the ventilation during a fire.

Response: Fire rated doors are required within the cross passage. These design details are specified in NFPA 130.

6. General — Because the Amtrak service is very limited, single tracking with appropriate signaling could be a viable, cost saving option in the tunnel section if it is planned to provide a separate Amtrak ROW in tunnels.

Response: The proposed rail crossing is specified to accommodate intercity passenger rail and Hampton Roads Transit. Separation of vehicle types is only required if LRT vehicles or some other non-FRA compliant vehicles are used in conjunction with FRA compliant vehicles such as Amtrak. Non-FRA compliant and Amtrak vehicles are not permitted to operate on the same system at the same time. Additionally, with the specified hours of operation for the DMU transit mode, assumed bi-directional operation throughout the entire operating hours, and the possible irregularity of Amtrak arrival times, a single track system would require blocks of time be taken out of the DMU transit schedule to allow Amtrak to cross the harbor. Additionally, it may not be possible to guarantee that those required time blocks would occur at the same time every day.

7. General — What are the projected lengths and locations of the tunnels and bridge sections of the Third Crossing.

Response: Candidate Build Alternative 9 has two sections as follows:

I-664 : North-South route connecting I-64 in Newport News to I-264 in Portsmouth.

Tunnel section: 2000 feet long.
Parallels the existing Monitor-Merrimac Memorial Bridge Tunnel.

Bridge section: 5200 feet long.
Continues south from tunnel exit, through I-564 interchange, into Portsmouth.

I-564 : East-West route connecting I-664/564 interchange with Norfolk

Bridge section: 5500 feet long.
Runs east from I-664/564 interchange to the tunnel.

Tunnel section: 2000 feet long.
Runs east from interchange tunnel entrance onto land at Norfolk International Terminal.

I, 2D CROSSING

U.S. Department
of Transportation

**Federal Railroad
Administration**

1120 Vermont Ave., N.W.
Washington, D.C. 20590

FEB 10 2003

Mr. William J. Novak
1101 King Street
Suite 400
Alexandria, VA 22314-2944

Dear Mr. Novak:

Thank you for providing a copy of Technical Memorandum No 2 on the Hampton Roads Third Crossing for our comments, which follow:

1. Page 10, first paragraph; normal adhesion for a diesel locomotive at low speeds is in the vicinity of 25%. The adhesion discussion appears to address conditions that are 50 or 75 percent of normal, which would translate to 12 or 18 percent actual adhesion.

2. Page 10, table; most Amtrak locomotives provide hotel power to the passenger cars from the main generator and thus reduce the power available to move the train. Assuming a car uses 50 hp, a typical figure for a single level car, then an 8 car train would reduce the power for moving the train by 400 hp. The table needs to reflect this. It should also be noted that at starting or low speeds it's weight on drivers that becomes the critical element, not horsepower.

3. Page 16, first paragraph; the Colorado Rail Co. claims to have built an FRA compliant DMU.

4. Design criteria, table 1; Note 1 should give curves by chord defination. Note 2 should refer to FRA. Vertical curves on railroads are usually give as "R" value, rate of change of grade as percent per 100 feet. Values vary with speed, but typically could vary from 0.9 at 45 mph to 0.6 at 80 mph. Length of a vertical curve is not usually a critical or limiting parameter.

5. Design criteria, table 2; rail weight in a tunnel with direct fixation does not need to be more than 115 lb/yd. Turnout size depends on usage and desired speed as well as available space. For this circumstance #20's would be a maximum size, while #15's might be more appropriate.

6. Design criteria, table 3; typical fully loaded intercity diesel locomotive weighs approximately 265,000 pounds.

7. Design criteria, table 4; note 6 should read ... by 1 inch for each 5 feet above top of rail for each inch of actual superelevation.

8. Design criteria, table 5; crossovers, and/or passing tracks if single track, should be included if train density and running times between tunnel ends become sufficiently long.

While the above comments address the basic design criteria, many specific criteria cannot be fully determined until station and yard/turnback facilities are located at both ends of the tunnel complex.

Sincerely,

Richard U Cogswell

R. U. Cogswell
Staff Engineer

HAMPTON ROADS THIRD HARBOR CROSSING
Technical Memorandum No. 2

Responses to Federal Railroad Administration Comments
Dated: February 10, 2003
Prepared by: Richard U. Cogswell

No.	Document Location	Comment
1.	Pg 10 Paragraph 1	Normal adhesion for a diesel locomotive at low speeds is in the vicinity of 25%. The adhesion discussion appears to address conditions that are 50 to 75 percent of normal, which would translate to 12 or 18 percent actual adhesion.

Response: Less than 12 or 18 percent has been modeled. Amtrak considered adhesion reductions of 25% and 50% from normal operating adhesion at various speeds. The normal operating adhesion used at low speed is less than 25% and decreases further with speed. Text has been clarified.

No.	Document Location	Comment
2.	Pg 10 Amtrak Operations Table	Most Amtrak locomotives provide hotel power to the passenger cars from the main generator and thus reduce the power available to move the train. Assuming a car uses 50 hp, a typical figure for a single level car, then an 8 car train would reduce the power for moving the train by 400 hp. The table needs to reflect this. It should also be noted that at starting or low speeds it is weight on drivers that becomes the critical element not horsepower.

Response: To conservatively account for ancillary power requirements, less than 65% of available horsepower was assumed for conversion into tractive effort. The tractive force assumed at rest is less than 25% of the weight on drivers. The analysis performed by Amtrak has been used extensively for NEC planning.

No.	Document Location	Comment
3.	Page 16 First paragraph	The Colorado Rail Co. claims to have built an FRA compliant DMU.

Response: Paragraph will be revised to read that no FRA compliant DMU is currently in service even though Colorado Railcar has received preliminary approvals from the FRA.

4A. Track Geometry Matrix — Note 1 should give curves by chord definition.

Response: Chord definition is the definition commonly used by railroad engineers. However, the project is a highway project and as such all curves are based on an arc definition. Additionally, all sources other than AREMA expressed their curve desires using the arc definition. To insure all parties are on the same basis, arc definition was chosen.

4B. Track Geometry Matrix — Note 2 should refer to FRA.

Response: Matrix to be corrected

4C. Track Geometry Matrix — Vertical curves on railroads are usually given as "R" values, rate of change of grade as percent per 100 feet. Values vary with speed, but typically could vary from 0.9 at 45 mph to 0.6 at 80 mph. Length of a vertical curve is not usually a critical or limiting parameter.

Response: Equation given in the matrix reflects the rate of change requirements as directed by Amtrak, 0.9 to 1.0 per 100 feet. Providing length of curve given by the equation as a minimum insures that desired rate of change is not exceeded. Effectively, the length of curve is not the limiting factor but its limiting value reflects the limiting factor of rate of change. Additionally, many of the stake holders and provisions of AREMA, reduce the rate of change requirement in terms of length.

5A. Track Structure Matrix — Rail weight in a tunnel with direct fixation does not need to be more than 115lb/yd.

Response: Rail weight selection is generally dependant on tonnage and track geometry. For passenger transit systems, the number of loading applications is a consideration for rail selection due to fatigue, even though the anticipated rail wear on such a system may not indicate the use of a heavier weight section. For economic efficiencies and convenience, one rail weight size is generally used on systems that do not run great distances or have variations in traffic volume and gross tonnages. Selection of rail weight to be determined during design phase.

5B. Track Structure Matrix — Turnout size depends on usage and desired speed as well as available space. For this circumstance #20s would be a maximum size, while #15s might be more appropriate.

Response: Turnout size was based on the most demanding mode that is anticipated to use the system with consideration given to potential future volumes and speeds. Number 20 turnouts were felt to be the best compromise to address all the present desires of the stakeholders while providing an opportunity for increasing the system's capacity at some future point in time. #20 turnouts will be indicated as desirable and #15s will be shown as minimum.

6.	Operations Matrix	A typical fully loaded intercity diesel locomotive weighs approximately 265,000 pounds.

Response: Locomotive weight is noted. Design loads covering intercity diesel locomotives are specified as a loading designation so that various consists will not need to be individually considered during bridge and tunnel design. Amtrak criteria for passenger-only applications are Cooper E-60 loading. Additionally, criteria for both modes were specified in order that the design engineers would have the most critical loading available.

7.	Clearances & Offsets Matrix	Note 6 should read "………. by 1 inch for each 5 feet above top of rail for each inch of actual superelevation."

Response: Document to be clarified to add clarity and avoid confusion.

8.	Emergency Considerations Matrix	Crossovers and/or passing tracks, if single track, should be included if train density and running times between tunnel ends become sufficiently long.

Response: Based on the plans for Candidate Alternate No. 9, the crossing will be a two track system. This should lead to dedicated directions assigned to each track. Locations of crossovers along the crossing will be considered. The number of crossovers needed and their location will be better able to be determined once specific geometries and alignments, and bridge and tunnel locations are established, and contingency emergency plans are formulated.

VDOT Comments
Conference Call

Date: March 11, 2003

Subject: VDOT comments on Third Harbor Crossing
Technical Memorandum No. 2
Design Basis Memorandum

By: Alan Cassiday, HDR

Participants:

Participants:	Ken Walus -	VDOT
	Alan Cassiday -	HDR
	Carl Hedgren -	HDR
	Bill Novak -	HDR

Ken Walus related the following comments:

1. General statement needed that the tunnels and bridges are not to be used for conveying freight railroad traffic at this point in time, or at anytime in the future.

2. Pg 8, Para 1&2: NEC reference needs to be explained where first appearing in the document.

3. Pg 20, Para 3: Does 10% vertical load specification apply to the walkway loading?

4. Pg 20, Para 4: No design criteria is specified for the crash wall should something not be included?

5. Pg 20, Section 6: Line spacing format changed from previous used at the list of the four rail modes and the bullet points.

6. Pg 21, Bullet points: High speed not used as a column heading, could not remember why it was agreed to do that. Can HDR refresh memory?

7. Pg 21, Bullet points: Add statement to the effect that crossing operational speed would be 79 mph or less.

8. Pg 21, Bullet points: Line spacing format changed from previous used at the list of assumptions.

9. Track Geometry Matrix, first row: specify D as degree of curve for clarification of design requirements.

10. Track Geometry Matrix, cell 1,1: Why is Amtrak specification given for light rail mode?

11. Track Geometry Matrix, cell 2,1: TTDC refers to what?

12. Track Geometry Matrix, cell 3,5&6: Why is Eu given as a range of 2.5 – 3 inches when other cells show as much as 4.25 inches?

13. Track Geometry Matrix, cell 7,1: Desirable and preferred are confusing. Which value is the one that is really wanted?

14. Track Geometry Matrix, cell 7,2 & 7,5-6: Why not specify 2000 feet for the curve rather than note formula definition.

15. Track Geometry Matrix, cells row 9: Should values all be the greater of the two specified limits?

16. Operations Matrix, first row: Speed should be indicated in Track Geometry matrix as a determining factor in geometric design.

17. Clearance & Offsets Matrix, first row: How was it decided that 15 foot should be the track centers given the range of values up to 26 feet.

18. Clearance & Offsets Matrix, vertical clearances: What specific structural element does the 17′ 6″ value reference?

19. Emergency Considerations Matrix, cell 1,5 & 6: Why is actual dimension specified when preceeding cells refer only to NFPA codes?

20. Emergency considerations Matrix: cell 2, 5&6: Minimum spacing of 2500 feet seems to be in conflict with current NFPA 130.

21. Emergency Considerations Matrix: What does right-of-way encroachment detection mean?

HAMPTON ROADS THIRD HARBOR CROSSING
Technical Memorandum No. 2

Responses to Virginia Department of Transportation Comments
Dated: March 11, 2003
Prepared by: Ken Walus

No.	Document Location	Comment
1.	General	General statement needed that the tunnels and bridges are not to be used for conveying freight railroad traffic at this point in time, or at anytime in the future.

Response: Concur. Statement will be added into the document text.

2.	Pg 8, Para 1&2	NEC reference needs to be explained where first appearing in the document.

Response: Concur, will correct text.

3.	Pg 20, Para 3	Does 10% vertical load specification apply to the walkway loading?

Response: Yes

4.	Pg 20, Para 4	No design criteria is specified for the RR crash wall.

Response: Design criteria is dependant on bridge layout and mode selection. Will include statement in text to the effect that at this time no criteria has been developed for the crash wall. Crashwall evaluation to be made during final design.

5.	Pg 20, Section 6	Line spacing format changed from previous used at the list of the four rail modes and the bullet points.

Response: Will insert lines to conform to overall document format.

6.	Pg 21	High speed not used as a column heading, could not remember why it was agreed to do that. Can HDR clarify?

Response: Due to constraints, higher speed trainsets will not operate at high speed within tunnel.

7. Pg 21 Add statement to the effect that crossing operational speed would be 79 mph or less.

Response: Will add statement.

8. Pg 21 Line spacing format changed from previous used at the list of assumptions.

Response: Will insert lines to conform to overall document format.

9. Track Geom Matrix First Row Specify D as degree of curve for clarification of design requirements.

Response: Will include notation.

10. Track Geom Matrix Cell 1,1 Why is Amtrak specification given for light rail mode?

Response: Footnote will be revised. 100 feet is in-street desired, 82 feet is in-street absolute.

11. Track Geom Matrix Cell 2,1 TTDC refers to what?

Response: Tidewater Transportation District Commission. Will clarify note to reference Hampton Roads Transit.

12. Track Geometry Matrix Cell 3,5&6 Why is Eu given as a range of 2.5 – 3 inches when other cells show as much as 4.25 inches?

Response: 2.5 inches is desired maximum , but acceptable limit is 3 inches.

13. Track Geometry Matrix Cell 7,1 Desirable and preferred are confusing. Which value is the one that is really wanted?

Response: Preferred is the preferred minimum, minimum is the absolute minimum. Will correct matrix wording to clarify.

14. Track Geometry Matrix Cell 7,2 & 7,5-6 Why not specify 2000 feet for the curve rather than note formula definition.

Response: Indicated value of 2000 refers to the curve radius rather than length of the vertical curve.

15.	Track Geometry Matrix Cells row 9	Should values all be the greater of the two specified limits?

Response: AREMA specifications are general considerations for freight and passenger rail. Notation to be revised.

16.	Operations Matrix First row	Speed should be indicated in Track Geometry matrix as a determining factor in geometric design.

Response: Alignments and geometry will not be developed by design speed. Design will have to fit the physical constraints dictated by the topography and equipment. The actual designated operating speed will be based on geometric constraints.

17	Clearance & Offsets Matrix First row	How was it decided that 15 foot should be the track centers given the range of values up to 26 feet.

Response: 26 feet was given as Amtrak specification in that it was not known exactly where freight and crossing traffic would be completely separated. 14 foot is the general standard for track centers. 15 foot was specified in order to increase the clearances by an extra foot and account for any concerns should tilt equipment be used.

18.	Clearance & Offsets Matrix Vertical Clearances	What specific structural element does the 17' 6" value reference?

Response: It refers to the underside of structure. The 17'6" clearance will provide sufficient clearance to provide for overhead catenary and its attachments. Note will be clarified.

19.	Emergency Considerations Matrix Cell 1,5 & 6	Why is actual dimension specified when preceeding cells refer only to NFPA codes?

Response: NFPA 130 refers to NFPA 101, Life Safety Code concerning emergency exit details. Under article 3-2.6 Egress for Passengers, no specific criteria are cited. 3' – 6" is recommended. Will change columns 5 & 6 to reference NFPA 130 with 3' 6' recommended.

20.	Emergency Considerations Matrix Cell 2, 5&6	Minimum spacing of 2500 feet seems to be in conflict with current NFPA 130.

Response: Agree. Will revise spacing and refer to NFPA 130 requirements.

21. Emergency Considerations Matrix What does right-of-way encroachment detection mean?

Response: System that notifies operations control when the right-of-way has been breached. For safety purposes, the indication is intended to warn operators of an outside obstacle encroaching within the clearance envelope.